FOUNDRY TRADE JOURNAL
Established 1902
WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

Vol. 72 Thursday, February 17, 1944 No. 1435

Builders' Castings

Of great significance to an important section of the foundry industry is the Government announcement that aerodrome site-preparing machinery is immediately to be utilised for the construction of building estates. Simultaneously, it was revealed that good progress had been made in the reduction in the number of types of bath patterns to be used in the near future. Moreover, we hear of great activity in ministerial departments charged with the simplification and standardisation of design of building materials and fixtures. We have failed to satisfy ourselves that the foundry industry is tackling this problem of post-war housing correctly. After all it is not dissimilar to the obtaining of a contract in the normal course of business, and to our mind needs the same technique. In these early discussions, such as are now proceeding, men with selling experience as well as technicians, should represent the industry. Quite a few of the temporary yet important Government officials were, before their appointment, sales managers and the like, and appreciate manifestations of their own art. The technician, on such occasions, believes that his mission at an important committee meeting or interview is to look for all the snags and difficulties, and, to use an Irishism, in general to cover himself in case he "falls down" on the job. The salesman, on the other hand, by his training is prepared to take a risk, well knowing that if he does not the representative of another concern in a competing industry will. At the moment, it is the duty of the salesmen-representatives of the foundry industry to label the whole of the fittings which have replaced castings in the wartime building regulations as "austerity," and to cash in on the prevalent—though sometimes ill-deserved—poor opinion of these goods. There is an urgency in this development of post-war housing, and a start may well begin before the termination of hostilities. It is particularly desirous that the foundry industry should make a good initial show, for in few industries is its voice more effective. In most cases, such as machine tool building, agricultural implement manufacturing, automobile building and so forth, the foundry just has to content itself to be only a department of a larger organisation. The success or otherwise of the foundries in catering for the post-war building programme will have a profound effect on the rest of the industry. The ability that many of the firms have shown in turning over to the manufacture of armaments gives confidence that they will return to their peacetime work with added zest and initiative. They have learnt much about the science of breaking down jobs into the simplest possible parts, but are reflecting upon the simplicity and ease of the old system whereby, after providing a minimum of equipment, they paid for and sold good castings, both prices being fixed by agreement. Under monopolistic conditions this is a desirable system of manufacture. The men need a minimum of supervision, and the cleverest and most hardworking operatives get the most money. But with the passage of time, there is now competition from other industries, and alternative foundry processes are available. The facts need tackling by giving attention to a concept based on two considerations only:—(1) a large quantity of standardised goods has to be made, and (2) they shall be made as castings. It is very tempting to take the least line of resistance by placing against this such thoughts as we have the shop, the organisation, and an experienced staff. No doubt the horse-hair cloth manufacturers were similarly placed some two decades ago. Obviously, initially the old system must be followed, but provision must be made to incorporate the best of the new conditions of manufacture at the earliest possible moment.

Contents

Builders' Castings, 133.—What is the Value of Your Product? 134.—Testing Cupola Furnace Linings, 134.—Cupola Operation and Control, 135.—Basic Electric Steel Practice, 140.—Industry and Education, 141.—Magnesium Foundry Practice, 143.—News in Brief, 148.—Personal, 150.—Treatment of Wrought Light Alloys, 150.—Company Results, 150.—New Companies, 150.—Obituary, 150.—Raw Material Markets, 152.

WHAT IS THE VALUE OF YOUR PRODUCT ?

"PLEASE QUOTE PRICE PER HUNDREDWEIGHT"

By A. R. P. Warden

The answer to this question depends upon the product. If a raw material, the price may be expressed in terms of per ton, per cwt., or per lb., etc., and will be standard for that material, with higher prices for the higher grades.

These standard prices will apply to steel joists, rails, plates, etc., bar, sheet, strip, etc., similarly to gunmetal, brass or aluminium ingots and pig-iron, all graded according to quality. All these may be called manufactured articles, although described as raw materials because standardisation is comparatively simple, due to the absence of a variable labour factor, with each type of material. What is your product? Machine tools? Clocks? Watches? Electricity meters? Electrical instruments?—or what? If any of the above, do you sell at a price per ton, per cwt., per lb., etc.? The answer will be a definite No, because the weights of the products have no relation to the value, may be due to the variety of materials included, but mainly because of the amount of labour cost incurred in working and finishing the materials and assembling the parts to produce the final product. Why, then, do buyers and designers expect to buy manufactured articles, such as castings, at a price per cwt.?

One designer confessed to the writer that he liked to buy castings at a flat rate per cwt., as it simplified his estimation of the cost of the materials used in his machines. He also admitted that he did not sell his machines by weight. Another designer forgot to consult his foundryman and designed a beautiful cabinet casting with difficult coring and very thin walls. When discussing the price, which was rather high per cwt., it was found that several complications which increased moulding and core-making costs were not really necessary. The reason given for the very thin walls was, "the job would do in sheet metal and the thickness was kept down to ¼ in. to keep down the cost." Alterations simplifying the design and increasing the thickness resulted in reducing the moulding cost from 20s. to 15s. per casting with less risk of a cracked casting, but an increased charge of 3s. for metal. The apparent net saving was 2s. per casting and the avoidance of hot and arduous labour required to move the core to prevent the casting cracking. The actual saving in moulding time amounted to an increase in the productive capacity of the moulder of 33⅓ per cent.

Therefore, just as in the case of other manufactured articles, it is well to remember that the price of castings is built up of Labour + Material + Overhead + Profit. A firm cannot do without the first two items; it realises the third is a necessity, and one of the reasons for the fourth is to provide an insurance against the time when it does not make any.

TESTING CUPOLA FURNACE LININGS

British Ceramic Abstracts for November includes details of an article carrying the above caption by Mr. J. M. Robitschek, which originally appeared in "Brick Clay Record." Three refractories were used in the tests, a "quartz-grog" brick, that is, a fireclay brick in which grog has been replaced by quartzitic grain; a "grog-brick," the body containing 7 pts. calcined non-plastic fireclay, 2 pts. uncalcined fireclay and 1 pt. ball clay; a monolithic lining which contained as chief constituent the quartzite-bearing kaolinitic clay, to which small quantities of a plastic fireclay of low Al_2O_3 content had to be added to ensure good workability. Tests were run in a strongly reducing atmosphere to prevent the oxidation of the FeO, which is present in cupola furnace slags in considerable quantities, and which is one of the causes of the destruction of the lining. It was found that the second brick offered better resistance to the chemical action of slags and because of its denser structure did not suffer slag penetration, but it was concluded that chemical reaction between cupola furnace slag and melting zone lining, although one of the causes of destruction of the lining, is not the primary factor which determines the life of the lining. It was deduced that the consumption of lining material per ton was inversely proportional to the SiO_2 content of the lining refractory; tests in which pieces cut from the first and second brick and natural sandstone and test-pieces made from the ramming mixture fired in an industrial kiln to 1,420 deg. C., were exposed to the action of several cupola slags, indicated that the chemical resistance of these test-pieces to the action of cupola slags was approximately proportional to their Al_2O_3 content or inversely proportional to the SiO_2 content.

Lack of Rigidity Decreases Life

The cause of the destruction of the lining was found to be its loss of rigidity. An increase in Al_2O_3 proves economical, and evidence suggests that the durability of the lining is determined by its refractoriness-under-load. Failure of fireclay refractories of high SiO_2 content may be caused by thermal stresses in blocks of too large dimensions. The durability of the lining is determined by the ability of the refractory to withstand mechanical stress at high temperatures. Consumption of refractories per ton of iron is above the average in furnaces that operate with a high-melting viscous slag, and depends to a very high degree on the duration of heat. The lowest consumption of refractories results from the use of silica brick or natural sandstone as lining materials. Monolithic linings of high SiO_2 content prove more economical than firebrick linings. Their use is restricted to furnaces of not too large diameter, and failure results if the lining cannot be dried and heated up slowly. Refractories are destroyed in the melting zone of the cupola furnace at a considerably higher rate than in the linings of other metallurgical furnaces; cooling of the melting zone lining or use of modern basic refractories could prove economical if large furnaces could be made to run for several days.

CUPOLA OPERATION AND CONTROL*

Correlation is made between the latest theories and current practice.

By R. C. TUCKER, M.A.

A technical Paper on the cupola must of necessity concentrate on one aspect and, if this Paper is largely devoted to consideration of the air supply, it is because this factor is so largely neglected in normal foundries. Also, it is hoped that by shortening the Paper more time for general discussion on cupola control will be available.

Air is compressed by a blower or fan and blown into a windbox or circular main. From there it goes through various openings in the side of the furnace, called tuyeres and meets hot coke. The immediate reaction is that the oxygen in the blast burns the coke carbon to carbon dioxide,

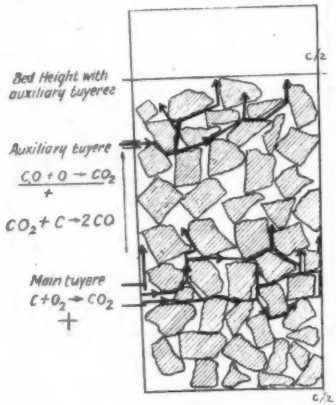

FIG. 1.—PROBABLE PATH TAKEN BY CUPOLA AIR-BLAST.

$C + O_2 \rightarrow CO_2$ + 14,550 B.T.U. per lb. of carbon, A subsidiary reaction of the moisture in the blast—$H_2O + C \rightarrow CO + H_2$—also occurs, with possible chain reactions alternating rapidly. Fig. 1 illustrates the probable path of the blast, and it will be seen that there is considerable resistance to the penetration of the blast to the centre of the cupola. If, however, at the plane AB the packing of the coke is uniform, then pressure applied through the tuyeres and backed up by sufficient volume to maintain it will lead to an escape of the centre gas upwards and its replacement by tuyere gas. The higher the pressure (and volume) the more easily will the tuyere gas replace the centre gas.

As soon as the oxygen in the blast is nearly exhausted, the carbon dioxide begins to react with preheated coke to form carbon monoxide.

$CO_2 + C \rightarrow 2CO$ = 5,850 B.T.U. per lb. of carbon. This leads to a twofold increase in volume and a loss in heat. This reaction should be complete before the top of the coke bed is reached. Now a given coke has a certain rate of combustion which depends on the nature of the coke surface exposed to the air and to the extent of that surface. Coke is cellular material and it can be said that nearly all foundry cokes have about the same type of cellular porosity.

1 ton of coke in 6-in. cubes has an area of, say, x sq. ft.

1 ton of coke in 2-in. cubes has an area of, say, 3x sq. ft.,

but the nature of the exposed surfaces depends upon a number of factors, such as type of coal, length of carbonising period, temperature of coking, size of oven, etc., so size analysis of coke cannot be adopted as an ultimate measure. One can, however, use it in checking consignments from the same source.

With small coke there are therefore several effects on the air/gas stream:—(1) A faster rate of burning in front of the tuyeres; (2) a larger proportion of carbon dissolving to carbon monoxide; and (3) greater resistance to the penetration of the blast.

The net result is a lower temperature of metal and the need for higher wind-box pressure and lower metal/coke ratio. A lower bed height is necessary, however, and in small cupolas where height is important and ease of penetration needs to be restricted smaller coke is advisable. Unless the secondary air is admitted near the top of the bed to reburn the carbon monoxide formed, the calorific value of this gas is lost. The "balanced blast" and Poumay cupolas provide auxiliary tuyeres to do this and, with proper attention to cleanliness, high temperature, and high metal/coke ratios are obtained.

The author's limited experience with the balanced-blast cupola was, however, unfortunate in that worse results were obtained than with a single row of rectangular tuyeres to which he reverted. The most practical advantage of the balanced-blast cupola is that the variability of the main tuyeres enables the correct setting for the cupola or output required to be obtained. Once set, however, the control is at the mercy of any operative who likes to be constantly changing things, and careful supervision is required to see that the tuyere settings are only changed by a competent authority. Incidentally, the cylindrical main

* A Paper read before the East Midland Branch of the Institute of British Foundrymen, Mr. W. H. Smith presiding.

Cupola Operation and Control

tuyere is not, in the author's opinion, a good shape, especially for large cupolas. The idea of keeping one tuyere always shut (in rotation) certainly keeps tuyeres cleaner, but does not entirely eliminate the poking bar. Nevertheless such cupolas are a distinct advance in design, although not the last word.

Fig. 2 shows the results of Du Douet,[1] which confirm in general figures obtained by Belden.[2] Full details are given in the Papers quoted.

The main point in tuyere design is that they can be kept clean and give good distribution of air on the hearth over as wide a range as possible on either side of the "rated" capacity. Most people agree that rectangular tuyeres of a total area of about one-quarter of the hearth area give the best results. It is important, however, to remember that the tuyere area does not cause restriction to the flow of the blast. The bottleneck is in the cupola bed.

D. J. Reese[3] discusses this point and several others in an excellent contribution to the subject. Taking a 48-in. cupola, the area of hearth would be 1,810 sq. in., and the free area, when full of coke, approximately 162 sq. in., but owing to the expansion of gas volume on heating to 1,500 deg. C., and the formation of carbon monoxide, the volume of the gas expands about sixfold, and therefore the resistance to flow increases and the "effective" area is reduced from 162 sq. in. to about 27 sq. in. The time of contact between gas and coke in the bed is about 1/88th second.

Taking the usual formula for resistance to flow in pipes, where Volume = a constant $\times \sqrt{\text{pressure}}$, the melting rate of a cupola is shown to be:

Melting rate (tons per hr.) =

$$\frac{\text{lbs. coke/hr.} \times \text{iron/coke} \times \frac{1}{2}\sqrt{P}}{2{,}240}$$

where P is the pressure in ounces.

Diameter of cupola in inches ..	24	36	48	54	60	72
Coke burned, lbs. per hour	450	1,000	1,800	2,300	2,800	4,000

From these figures and assuming for convenience a wind box pressure of 16 ozs. ($\sqrt{16} = 4$) in each case. Reese calculates further normal figures, and these are detailed in Table I.

Of course, wind box pressure is not the same for such widely differing cupolas in practice and blast pressure is a somewhat controversial subject. Blast pressure is a necessary evil. It is required to enable the necessary weight of oxygen to enter the tuyeres to combust a certain amount of coke and thus melt a required amount of metal, and so, by itself, it has no meaning.

Defects of Control by Blast Pressure

As a method of control it has certain defects, as the following argument shows:—Take a cupola in its normal operation when with a given output and coke charge to suit it is found that, say, 12 ozs. pressure is necessary to maintain the output, *i.e.*, force the required

TABLE I.—*Normal Figures for Cupola Operation* (*Reese*).

Diameter, in...	24	36	48	54	60	72
Output, tons per hour ..	2½	5	9	11½	14	20
Air, cub. ft. per hour at N.T.P. ..	1,000	2,270	4,025	5,100	6,300	8,930
Air, dry, lbs. per hour ..	—	177	314	398	492	696

(Dry air = 0·078 lbs. per cub. ft. at N.T.P.)

weight of air through the cupola per minute. Let the cupola be blown by a positive blower with a rheostat control fixed at a certain mark by experience. Now

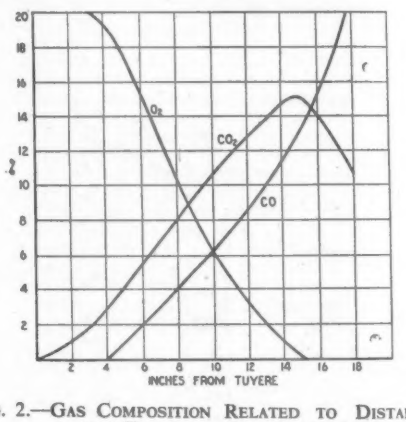

FIG. 2.—GAS COMPOSITION RELATED TO DISTANCE FROM TUYERES. (DU DOUET.)

suppose some deleterious factor becomes operative, such as sticky slag, small coke or scrap, and at the usual setting, the blast pressure rises. The result is that, due to the higher pressure the blower slows down and the volume of air decreases. Thus a two-fold decrease in penetration occurs—increased resistance plus decreased velocity.

Action may be taken to reduce the pressure to normal, and a further reduction of air velocity and penetration occurs. Output drops still further. Alternatively the rheostat may be moved to restore the air volume to its normal rate, and the blower may or may not "take it." If it does the wind box pressure will rise further and power cost will increase. Let the cupola now be operated by a fan blower. The same defect in operation occurs. Pressure does not alter, but the fan delivers less volume, penetration and out-

put fall, but no warning is given by the pressure gauge.

Control by Volume

The only sure way of controlling the air supply is to measure its volume. With a positive blower this can be done by a double record of pressure and current consumed. When both are constant then the volume will be constant, but when variations occur the line of reasoning set forth above in the first example must be applied.

Campbell and Grennan[4] have published useful and interesting calculations. Abstracts from their tables give the following information:—

At the tuyeres 2.66 lbs. dry oxygen combine with 1 lb. carbon; or 11.5 lbs. dry air combine with 1 lb. carbon; or 151 cub. ft. air (N.T.P.) combine with 1 lb. carbon. (Not all the carbon charged reaches the tuyeres.) Under normal conditions the stack gases are composed of:—14 per cent. CO_2, 12 per cent. CO, and 74 per cent. N_2; the limits for CO ranging from 7 to 20. Secondary air (balanced blast) gives the figures near 7 per cent.

As the result of experiments and calculations Hurst[5] concludes that 50 per cent. of the calorific value of the coke charged is utilised in melting and superheating the iron charge, and on this basis Campbell and Grennan construct their Table II (Table III), assuming the following constants:—

Melting point of cast iron 2,250 deg. F. (1,232 deg. C.).
Specific heat of cast iron 60-2,250 deg. F. = 16 BTU's per lb. iron per deg. F.
Latent heat of cast iron, 41.5 BTU's per lb. iron.
Specific heat-molten cast iron, 0.23 BTU's per lb. iron per deg. F.

TABLE II—*Campbell and Grennan's Table I (Abstract).*

Combustion condition.	Carbon to CO_2.	Final		Flue gas analysis.			Lbs. O_2 per lb. carbon.	Lbs. air per lb. carbon.	Cub. ft. air per lb. coke (90 per cent.)
		CO_2.	CO.	CO_2.	CO.	N_2.			
A	100	100	0	21	0	79	2.66	11.5	136
D	85	70	30	16.6	7.1	76.3	2.26	9.8	115
E	80	60	40	15	9.9	75.1	2.13	9.2	109
F	75	50	50	13	13	74	2.00	8.7	102
G	70	40	60	10.9	16.6	72.5	1.86	8.1	95
H	65	30	70	8.7	20.3	71	1.73	7.5	88
K	50	0	100	0	34.7	65.3	1.33	5.8	68

TABLE III.—*Campbell and Grennan's Table II (Abstract).* (Coke assumed to contain 90 per cent. carbon).

Combustion condition	B.T.U.s per lb. coke (90 per cent. C.).	Lbs. iron melted and superheated to		
		1,400 deg. C.	1,455 deg. C.	1,510 deg. C.
A	13,095	14	14	13
D	10,341	11	11	10
E	9,423	10	10	9
F	8,505	9	9	8
G	7,587	8	8	7
H	6,669	7	7	7
K	3,915	4	4	4

D. J. Reese[3] gives recommended bed heights above the tuyeres:

Blast pressure, ozs. ..	..	4	8	12	16	20	36
Minimum bed above tuyeres, in. ..	..	21	30	36	42	47	63
Recommended above tuyeres, in.		27	36	42	48	53	69

These tables give the appropriate range of figures for differing conditions. From which, say, a 54-in. cupola giving an output of 10 tons per hr. will require at a metal/coke ratio of 9:1, 4,000 cub. ft. of air per min., a coke charge of 211 lbs. and a metal charge of 2,000 lbs. If blown at a pressure of 12 ozs. a bed height of 36 to 42 in. above the tuyeres will be necessary, but one cannot say *a priori* that this pressure will give 10 tons per hr. under the conditions given above. It is known that a volume of 4,000 cub. ft. of air will give the figure required. How can one measure this air?

Incidentally and *en passant* a slight controversy is noticed in results quoted by different authorities.

At the Tuyeres

1 lb. carbon requires 151 cub. ft. air.
1 lb. coke *charged* requires about 102 cub. ft. air.

Some carbon is lost as CO (about 25 per cent.), so that

1 lb. coke *charged* requires about 102 cub. ft. air if CO_2 = 13 per cent. = CO per cent. (combustion condition F.).

Cupola Operation and Control

An average figure quoted by Bolton is 115 cub ft./lb. coke, and it is not necessary to explain the difference between 115 cub. ft. and 102 cub. ft. as leaks in the system. Even in the most poorly maintained cupola such leaks cannot be more than 5 per cent. of the air blown. The author is convinced that the discrepancy is due to bad calibration of the measuring instruments, and a definite case in point will explain why.

An Example from Blast Furnace Practice

In a blast furnace plant the blower was fitted with a volume meter. The flue gas was analysed continuously, coke was analysed and weighed, etc. Taking the volume meter reading, the carbon consumed at the tuyeres was calculated to be 400 lbs. per ton of iron more than that charged into the furnace. Knowing the coke weight and analysis and the analysis of the exit gases, the author was able to calculate from the unchanged nitrogen what the air volume actually was, and the coke consumed away from the tuyeres was found to be fairly normal at 300 lbs. per ton of iron. Now this volume meter had been giving and continued to give very useful service. It showed how the furnace was "taking the air," and gave prior warning of poor conditions leading to increased resistance and bad furnace working. It must therefore be decided how one is going to proceed. Is one going to require an accurate knowledge of the air blown or an empirical figure which will give sufficient information for an hour to hour or day to day control of uniformity?

Volume Measurement

The use of the pressure and ammeter on a positive blower has been mentioned. Volume meters are available which work on the diaphragm, Venturi or Pitot tube principles. All of these require an accurate knowledge of the inside diameter of the main, and must be set in a straight length of main at least 4 × diameter from a bend or constriction (valve). They should be of a recording type and, on the same chart, should be recorded the blast pressure and any notes such as moisture content and inlet temperature of the air, spout temperature and output of iron, cause of irregularities, etc.

The instrument must be calibrated for the normal working pressure and corrections for moisture applied. The connecting tubes must be blown or washed out at frequent intervals, and the leaks in the air system kept to a minimum. A N.P.L. certificate of accuracy of calibration can be obtained in peacetime and, if quantitative calculations are to be made, such as comparing different brands of coke or bed heights, then it is a good investment.

A method for foundry checking of such instruments is given by W. Pennington*; it is similar in principle

TABLE IV.—*Campbell and Grennan's Table IV (Abstract).*

Diameter, ins.	Area, sq. in.	Volume of coke charge 6 ins. high.	Coke charge lbs.	Metal charge, lbs., at metal/coke ratio.				
				7 : 1	8 : 1	9 : 1	10 : 1	11 : 1
32	804	4,824	74	518	592	666	740	814
48	1,385	8,310	128	896	1,024	1,152	1,280	1,408
54	2,290	13,740	211	1,477	1,688	1,999	2,110	2,321
60	2,827	16,962	261	1,827	2,088	2,349	2,610	2,871
72	4,072	24,432	376	2,632	3,008	3,384	3,760	4,136

TABLE V.—*Campbell and Grennan's—Table IV (Combustion condition F).*

Diameter ins.	Coke charge lbs.	Cub. ft. air.	Cub. ft. air per min. to combust/coke charge in			Melting rate (tons per hour).					
						9 : 1			8 : 1		
			4 mins.	5 mins.	6 mins.	4 mins.	5 mins.	6 mins.	4 mins.	5 mins.	6 mins.
32	74	7,548	1,887	1,509	1,258	5	4	3.3	4.4	3.6	3.0
42	128	13,056	3,264	2,611	2,176	8.6	6.9	5.8	7.7	6.1	5.1
54	211	21,522	5,381	4,304	3,587	14.2	11.4	9.5	12.7	10.1	8.4
60	261	26,622	6,656	5,320	4,437	17.6	14.1	11.7	15.6	12.5	10.4
72	376	38,352	9,588	7,670	6,392	25.4	20.3	16.9	22.6	18.0	15.0

to the blast furnace example quoted above, and depends upon careful cupola melting under uniform conditions, with measurement by weight of the coke, metal and limestone charged over a period, and the metal tapped over a similar period.

R = iron/carbon ratio.
C = air volume cub. ft. per min. (0 deg. C. 760 mm.)
D = melting rate tons per hr.
X = per cent. CO_2 in cupola gases.

$$D = 7.71. \times 10^{-4}\ RC\left(\frac{52.48 - X}{94.13\ X}\right)$$

Measure melting rate by weighing and timing from empty hearth to empty hearth. Measure R by weighing coke and metal charges and analyse coke (no steel in charge and check by calculation that no carbon enters or leaves the metal).

If this is not confirmed then the above equation gives the correction:—

X = per cent. CO_2 in flue gases which can be determined by a sampling tube and Orsat apparatus (every 15 mins. is recommended).

C is then calculated in cub. ft. per min. at N.T.P. and checked against the meter reading.

Continental Papers by Busek, Czyzewski[7] prove that, for Polish coke, the optimum value of the blast volume = 100 cub. meters per sq. meter per min. on the principle that the space between the coke lumps is 40 per cent., and claim to confirm this by experiments on actual cupolas.

100 cub. m. per sq. m. per min. = 325 cub. ft. per sq. ft. per min. (Bolton).

and comparing this figure with the results shown by Campbell and Grennan for, say, a 54-in. cupola, one has it that this is equivalent to combusting a 211 lb. coke charge in less than 4½ min.

	4 min.	5 min.	6 min.
Czyzewski, 5,000 cub. ft. air per min. c. g. ...	5,381	5,304	3,587

which is reasonable agreement.

Bolton, in the discussion, states that 120 cub. ft. per sq. m. per min. is more in line with average British practice (how obtained?), and this figure would make Czyzewski's figure 6,000 cub. ft. air per min., which is not in agreement.

Czyzewski's[7] experiments, on the other hand, do show the effect of small coke, in that he had to increase the volume to 140 cub. m. per sq. m. per min. to get hot metal. It is necessary also to question, as did Bolton, that his allowance for leaks was 20 per cent. before he could correlate his theoretical figures with practice. Again, one must question the accuracy of the measuring instrument. It is not stated how the air was measured.

Barrigozzi,[8] for instance, discusses this point at length and mentions that Leopold Schmid records having frequently found the real blast volume to be 0.8 of the reading, and even by taking such corrections as the blast is always in excess of theoretical (20 to 50 per cent.).

Moisture Control

Gas sampling creates a difficult, but not insuperable, problem. Moisture in the blast must be allowed for accurate results. The coke will not burn at its proper rate with less than 3 grains per cub. ft., and the normal moisture in this country is probably about 7. In America, automatic plants for controlled moistures are in operation, the most successful seeming to be those based on the abstractions of moisture by lithium chloride solution of a suitable density and regeneration of that density by steam heating and water cooling. It is not thought that such plants would prove economical over here owing to the more constant and somewhat lower average moisture.

Moisture in the blast has the following effect:—

$H_2O(18) + C(12) \rightarrow H_2 + (C)O$ ($C \rightarrow CO$ already accounted for) – 5,806 B.T.U. per lb. water vapour. Thus, for each 1 lb. of water vapour injected, there is lost 2 to 3 lbs. of carbon and the heat it would have given on combustion to CO_2/CO and also absorb the heat of reaction. Also, water vapour is measured by the meter as air, and so with high moisture one suffers from oxygen deficiency or slight loss of output. This is very small even at 7 grains per cub. ft. = 1 per cent. of water vapour.

Take the effect of moist air containing 7 grains per cub. ft.: 11.5 lbs. dry air required for every lb. of carbon; 11.5 lbs. air containing 0.115 lb. water; 0.115 lb. water react with 0.08 lb. carbon; so that for every 7 grains water the process requires an extra 8 per cent. of coke, or roughly 1 grain per cub. ft. of air leads to the loss of 1 per cent. of the coke. In addition to this, of course, the absorption of heat in the water-gas reaction is an important loss.

It will be seen, therefore, that a considerable amount of work has been done on elucidating the way a cupola works by calculation and correlation. One must, however, always remember that the cupola is a "maid of all work," and only in very special cases should it be burdened with too many control instruments.

But some controls are necessary:—A bed gauge; weighing of materials; pressure and volume recorder, even if these do not give the "right" figure; a check of the output and spout temperature; and a record of the findings in a cupola log book. Foundrymen will be surprised what can be done to tighten up cupola efficiency with very little expense.

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SAVE STILL MORE PAPER

BASIC ELECTRIC STEEL PRACTICE

SOME AMERICAN TRENDS

The American Institute of Mining and Metallurgical Engineers recently promoted a Symposium on Basic Electric Steel Practice in order to discuss some of the major trends which had taken place in the last few years. The extent of electric furnace steel output was conservatively estimated at 2,000,000 tons of acid plant in relatively small foundries, while the production of basic steel was said to be some 6,000,000 tons of ingots in larger steelworks units. The economic position of electric furnaces as opposed to the open-hearth in peacetime was also discussed, and it was thought that in this connection there might be some problems to be solved as wartime demand decreased.

Various points of view were expressed, and an examination of the complete proceedings indicated that the divergent views which were expressed were, in the main, due to the fact that some speakers were discussing very small plants working on routine production, while others were dealing with 70-ton units which were melting a variety of steels. Machine-charged furnaces were claimed to show an advantage of $3 per ton over the hand-charged designs. The growth of machine charging in electric-furnace shops, it was thought, might ultimately have an influence on the present standard design of open-hearth charging boxes.

Other views expressed indicated that the main electrical equipment and auxiliaries supplies to a large furnace have become inordinately complicated and expensive, even though the electrical engineer may give a good reason for each addition. Simplification was desired.

Regarding refractories, it was agreed that the roof, rather than sidewalls or bottom, is the critical part of the structure, and it is surprising that a silica brick roof is endured on a basic-lined furnace. The extra cost of a basic roof may well be repaid by its longer life and resistance to iron oxide spatter during the melting stage. (Hot metal charges should also cut down damaging temperature fluctuations.) Due to the non-conducting nature of firebrick, it is apparent that water cooling—whatever good effect it may have in keeping the outside of the furnace cool—will not reduce the temperature of the inner face until the wall has wasted away nearly to the cooler. Plastic refractories which can be shot into the furnace with air guns were highly to be desired.

Oxidation Slags

Karl L. Fetters gave an excellent exposition of the nature of a desirable slag to be shaped up after this melt-down period. He regarded a minimum weight to be 2 per cent. of the bath, as compared with 10 per cent. for an open-hearth heat. Basicity varies greatly, plant to plant, lime to silica ratio being 0.7 to 4.0, although a ratio of 2.0 or 2.2 appeared to be optimum for carrying off phosphorus and sulphur while reducing the silicon practically to zero and leaving behind as much manganese and chromium as possible in the metal bath. A lime-silica ratio of 1.75 may be associated with a residual phosphorus of 0.03; a ratio of 2.5 will bring phosphorus below 0.01 per cent., other things being equal. Generally speaking, electric furnace slags contain more MgO from the banks than open-hearth slags do, the manganese is lower because pig-iron is seldom charged, and phosphorus is usually lower. They also are better "shaped up"—meaning a nearer approach to equilibrium conditions. Iron oxide content depends inversely on the carbon in the steel at the end of the boil; it can be lowered by dipping electrodes in the bath, and raised by adding ore.

Deoxidation Period

H. McQuaid gave the reasons for the next stage in electric steel melting as a logical sequence of the oxidation stage. In the first part of the heat the metallic bath is filled with reactive iron oxide; in the second (refining and deoxidising stage) this iron oxide must be removed—as well as other metallic oxides present. A good start is by "reboiling" with ferro-manganese or spiegel. The iron oxide in the metal is reduced by manganese, and the manganese oxide formed will combine with silica. If temperature is high enough (and this is extremely important), the alumina and manganese silicates can liquate to the slag. Such deoxidation by manganese is temporary, for the metal is still covered by the oxidising slag, and this is therefore skimmed. Practically all the manganese can be added just before slag-off without more than 20 per cent. loss, a practice followed by some melters with very good results. In some other plants the main manganese addition is made after slag-off.

McQuaid believed in adding the manganese immediately after slag-off, as well as some strong deoxidising agent (aluminium or Si-Al-Ca combinations). This reduces oxygen in the metal to such a low point that the slag will shape up quickly and all other major alloying additions can be made immediately. Ingredients for the final deoxidising slag, already mixed, can be rapidly shovelled in, melted, and "used as a blotter to mop up the rising oxides."

Carbide slags are very popular in the refining stage. H. C. Bigge cited the following, used on 75-ton heats of S.A.E. 3312: 2,100 lbs. lime, 300 lbs. 80 per cent. ferro-silicon, 375 lbs. spar, 150 lbs. powdered coke. Other speakers said they like to get as much lime in as possible and still have a fluid slag; total slag weight of about 2 per cent. of the bath seems to be a satisfactory average. Frequent small additions of powdered coke or ferro-silicon are necessary to keep this slag well deoxidised.

One of its important functions, of course, is to absorb sulphur, of which perhaps only one-quarter has been taken off in the oxidising slag. The exact mechanism of the sulphur reaction with calcium carbide is unknown; Reagan mentions that now and then a heat is encountered where sulphur remains stubbornly constant. In such cases it is better to slag off and make up a new carbide slag. Sulphur elimination, as well as final deoxidation, depends on action

(*Continued on page* 148.)

INDUSTRY AND EDUCATION

Discussion in Leicester

This Conference Paper, by Mr. G. L. Harbach and Mr. J. R. Horton, was discussed by the East Midland Branch of the Institute of British Foundrymen at a meeting held in Leicester. It was opened by the chairman, MR. W. H. SMITH, who said the foundry industry would have to do much more than it had done previously, and something after the nature of a third party insurance would have to be applied to the foundry as a whole, because whilst some employers gave facilities to apprentices in their own workshops, the whole of the industry received the benefit, which was unfair. The cost of training apprentices must be national. Every foundry likely to benefit should make some provision towards the cost. The teaching staff must be preferably men of mature practical experience. Perhaps Mr. Harbach would comment on whether he thinks it was likely that sufficient experienced teachers could be drawn from industry who could impart knowledge.

MR. HARBACH, in reply, said an ample supply was available if they could be persuaded to act, because but few were keen on teaching, even if possessing aptitude. It was debatable whether the foundries which trained apprentices systematically were the losers, because the whole industry benefited. The financial side could best be dealt with by a foundry owner.

MR. H. P. RADFORD disagreed with the suggestion of the White Paper that pupils should be segregated at the age of 13; he preferred the deferment until 14. In the technical schools the daytime class could be augmented. The visits to works by boys just over 14 was worth supporting, especially if followed by lectures in the canteen by one of the teachers, so that the possibilities of that particular trade as a career are immediately stressed. Facilities for washing, baths, and changing of clothes were essential, and managements must insist that these facilities were used. The employers in Leicester allowed their boys to go to Technical Colleges during the daytime as part of their apprenticeship.

MR. HARBACH supported Mr. H. P. Radford's plea for the raising the segregation to 14, but that was not the idea. It was intended that there would be three types of education running parallel for pupils over the age of 13, and up to the age of 14½, vocational training would not be applied. Works' visits were featured in the White Paper, as there would be direct contact with industry to give the student an idea what the industry was like. It was a good idea to have a lecture immediately following the visit; this would probably crystallise quite a number of comments. Washing facilities, it was suggested, were not always used, yet from personal knowledge at two firms which provided such amenities, over 90 per cent. of the workpeople made proper use of them. An improvement in good housekeeping was a most important factor if the industry was to attract apprentices, and with higher education this would be essential. The firm with which the authors were associated (Newark) also permitted their apprentices to attend the local Technical College one day per week as part of their training.

Employer's Viewpoint

MR. S. H. RUSSELL (Past-President) thought the authors had produced an excellent Paper; it was written in the early part of the year, and it was interesting to note how parallel the lines were running with those of the White Paper since published. In their introductory remarks they had also given a clear picture of the new educational scheme. If this scheme did replace the present scheme, a great snag will be the problem of the voluntary schools which would produce much controversy. Unfortunately, the main features of debate and controversy in this Bill would be to many foundrymen just side-shows, and it would be most unfortunate if such controversy delayed action on what were essentials to industry. It was quite clear that as quickly as buildings could be prepared and staff found, modern education would include a secondary school education. The Grammar Schools, as we now know them, would be broken up and there would be nothing like so many students, and he hoped that 50 per cent. of boys and girls now in Grammar Schools would be found in the technical schools. The Grammar School gave an academic training and the pupils in the main would pass on to banks, offices, etc. An equal proportion would be technical school students who would have had a different type of education. As to the new modern school being equal in status to the technical school, he thought this would be difficult, but it was from this modern school that industry would get its ordinary workpeople. All these boys would then have to go to school for one day each week until they are 18. The scheme, when it came into operation, was that the boy who left school when he was 15 would do a part-time training, but the boys who were already in industry would not be compulsorily sent to part-time colleges. It would be a slow job, perhaps five, six or seven years before there were people in the works who had had three years' part-time training.

The Time Factor

The boy from the Technical College will be of rather better calibre. He was the boy who should become a foreman, etc., or be on the executive staff. That was the picture in discussing the new education system, and it was pretty certain to come into force.

The raising of the age limit was some way off yet, as, first, there were insufficient schools, classrooms and teachers. Young People's Colleges had to be equipped to absorb the part-time day students, which would also provide facilities for games and physical recreation, in addition to the teaching of various basic subjects. It would be realised that it may be eight or ten years before all of this comes into completion, and industry could wait eight or ten years.

Proposals have recently been drafted for the training of apprentices, and these proposals were tied up with the new scheme of education. The employers should certainly consider the economic conditions, this being outside the scope of the Institute. The em-

Industry and Education

ployer had at last recognised this big problem and the reasons for this were many. Education up to now had had this academic background, as Mr. Harbach had explained. Quite often this education had produced a poor quality recruit, and many people insisted that he was not worth training anyway; possibly the new scheme would remedy that. The employer had often failed to train the apprentice properly; he had just used him as a source of cheap labour.

The New Conditions

So many foundries were now tending to mass-production methods, in which they did not need many craftsmen, and did not use them. The whole of the moulding or core-making was done on the machine; the labour was semi-skilled or unskilled, and often involved very hard work. If such foundries visualised the need of craftsmen at all, it raised a big problem as to how and by whom they were to be trained, and this problem had hardly been thought about yet. It did seem that foundries, which were in a position to train craftsmen, might have to receive some financial help from such mass-production firms in return for training the small percentage of craftsmen who were to go to mass-production plants.

Industry had got to improve its working conditions and improve the cleanliness in the shops if the children were to have a bigger bias towards foundry work. He was convinced that a boy would never return home clean if there were not adequate facilities for changing his clothes, and such accommodation must be provided. There should be two lockers, one for dirty clothes, and one for clean clothes.

MR. F. DUNLEAVY said all thinking foundrymen would support any reasonable scheme that would assist the industry to recruit apprentices, and to keep them. If a scheme of training could be adapted to suit the foundry apprentice, teaching him, in the firm's time, the fundamental principles of his craft, together with melting practice and some elementary metallurgy, taking care to avoid all the pitfalls of the usual continuation classes, then the industry would have a chance of holding the interest of the apprentice.

MR. HARBACH said it was generally understood that the conditions in the foundries must come up to the best in the country, first to attract the apprentices and then to hold them.

The thanks of the meeting were expressed by Mr. J. F. Measures and Mr. R. F. Orme, and Mr. Harbach replied on behalf of Mr. Horton and personally.

Written Communications

MR. H. F. FLAVELL wrote:—It is pleasing to know that the Institute are taking such an interest in education for industry, as such education will doubtless play a very big part in post-war business.

The old system of dashing from work, sometimes even without tea, to technical schools three nights each week, is, I think, due for a change, and if a scheme can be evolved whereby young employees are given facility for obtaining a practical training in their particular trades and during the day-time, then I think something worth-while will have been achieved, and the subsequent results will doubtless reflect favourably on industry generally and certainly on the firms individually. I have heard it said by some employers that to give facilities for special training to employees is often a waste of money and time to them, as some of the individuals concerned eventually leave to take up better positions. This argument, I think, could be countered quite easily in so far that if suitable schemes for employees were inaugurated, we should in time find that a "good man" would follow a "good man."

A man's competence is always limited to the amount of knowledge he has of any particular subject or trade, and it follows that, whilst the individual may be competent at his own job without any special training, he would certainly be more competent if he had such training. How often we find "outside men" soliciting business who know little or nothing about the practical side of the trade they represent.

In his contribution to the discussion at the conference as to the type of teacher for industrial education, I think Mr. Russell scores a "bull" by his desire for a more practical and less academic atmosphere in our schools.

The "Appointed Day"

MR. HARBACH, in reply, said: The two points mentioned had already been noted before. Regarding the question of who is responsible for the education, the employers would gradually be forced to take more interest. There was a scheme put forward after the last war whereby apprentices should attend a technical school or college one day per week. The scheme was to start on an "appointed day," but the day never came, although it was voluntarily adopted in Rugby and elsewhere. The present White Paper proposed a similar scheme to commence on an "appointed day," and it was up to everybody to see that it became fact this time.

Many would remember when attending the technical college having to dash off from work, frequently without a meal, and would agree that this was undesirable, but the point arose that students who continued for the full course had to be keen to sacrifice so much leisure: whereas with greater consideration and improved facilities for students, it may be that less keenness and appreciation would be shown. It boiled down to the fact that most things obtained with difficulty were valued more highly than those obtained easily, but undoubtedly whatever work one puts in, one probably obtained a return sometime.

Factors Affecting Recruitment

MR. F. BUTTERS wrote: The authors' reference to Britain's industrial pre-eminence during the 19th century may be one reason for the complacent attitude of the foundry industry in the years following the Great War with regard to the training of apprentices. A

(*Continued on page* 146.)

MAGNESIUM FOUNDRY PRACTICE

DISCUSSION IN LONDON

Helpful hints on running are given

When Mr. Ian Ross, of Magnesium Castings & Products, Limited, and of High Duty Alloys, Limited, presented his Paper to the London Branch of the Institute of British Foundrymen, which has been printed in our last two issues, many questions of a practical character were answered. The discussion was opened by MR. ROSTRON, who said that at one time it was the general practice in the magnesium industry to tail out the runners in order to trap dross, but he had noticed that in the making of the casting described in the Paper the runners formed a complete circle which was not broken in any way. He asked whether the former practice had been discontinued generally, and, if so, why.

MR. ROSS replied that as a general rule founders would agree that it paid to tail out a runner where possible. This meant that the metal passed the gate and came to a dead stop; therefore any dross carried by the first metal entering the runner channel was trapped. Generally speaking, he believed that this was the best practice. At the same time there was no reason why the method which involved a complete circle of the casting should not work. In the manufacture of the job under discussion, the arrangement of the runners had been evolved gradually, and although good castings had been produced from the beginning, there were also many bad ones, and headaches were common before they had arrived at a method which was really efficient.

Inhibitors

MR. ROSTRON, recalling the use of ammonium bifluoride in the moulding sand, asked if the same percentage were used in the core sand.

MR. ROSS said that it was.

MR. V. C. FAULKNER (past-President) asked why sulphur sand was not used.

MR. ROSS replied that when his company had started making castings in magnesium all the sulphur patents were tied up by the Germans and by the people in this country who were operating the Elektron Patents. His company did not work to the Elektron Patents. They had had to find another inhibitor, and now, having tried sulphur, preferred to use ammonium bifluoride, for it was very much more pleasant to work with on account of decreased fuming.

A SPEAKER asked what were the relative weights of the casting when fettled and when unfettled.

MR. ROSS said the weight was about 750 lbs. when cast, and when despatched it was approximately 250 lbs. Presumably it was about 20 or 30 lbs. lighter still when machined.

Running Methods

MR. ROSTRON, pointing out that in the illustrations the channels were shown at the bottom, asked whether it was found preferable to have the channels in the bottom rather than in the top.

MR. ROSS replied that this question was always a matter for argument, but he had found when casting magnesium, and also aluminium, that the runner should be designed to prevent turbulence, and if the speed of the pour is controlled by the use of small downrights, and wherever possible a roving channel which allowed the metal to flow some distance before entering the actual gates, a smooth pour was effected. When the metal reached the bottom of the downright it flowed quite slowly along the channel, which was roomy. It could not move fast because there was no pressure, and therefore it entered the mould very quietly. The steel wool which could be seen in the channel was used to form something in the nature of a trap, and served as a steadying influence, proving very effective indeed.

MR. E. M. CURRIE asked whether core gauges or core strips were used.

MR. ROSS replied that all cores were gauged and that the gauges were checked regularly.

Chills

MR. CURRIE asked what material was used for chills.

MR. ROSS said it was cast iron. At one time bronze had been used in the aluminium foundry, but a too clever buyer had bought some yellow brass for the purpose which had given trouble, and subsequently cast iron was used.

MR. CURRIE asked if the sandblasting of the chills rendered them good enough for their purposes, or whether any further preparation was necessary.

MR. ROSS said they must be very dry and they must be clean; one could rumbler them if they would stand it. Apart from that, they were coated with red iron oxide.

MR. CURRIE said that, although it had been indicated that steel wool was used at a point about half way around the runner system, he gathered that it was used also in other parts.

MR. ROSS agreed that it was.

MR. CURRIE, referring further to the use of steel wool, said he supposed that the amount used was limited in relation to the area of the channel, for if too much of it were used it was likely to have a chilling effect on the metal.

MR. ROSS agreed that that would be so if the steel wool were rolled too tightly. The men engaged on the work had acquired the knack of rolling it up so that it served more or less as a fine sieve, and the ability so to roll it was regarded as an accomplishment.

Asbestos Sleeves

As a matter of interest he mentioned that at one time two of the risers had given trouble. No particular reason, such as a major change of section, was apparent, but shrinkage persisted at these areas. This trouble was overcome by the insertion of asbestos

Magnesium Foundry Practice

sleeves in the risers. These sleeves insulated the metal from the sand and enabled it to remain "alive" very much longer, therefore providing extra feed for the job. They were just like rolls of asbestos paper and were slipped into the risers. He had seen them used some years ago in Germany, where they were regarded by the particular foundry as being their best discovery in a year. The thickness of the asbestos was about $\frac{1}{32}$ in. The sleeves could be cut to shape by the suppliers. It was most important to ensure that they were dry when used, otherwise the metal would blow off them.

Porosity and Venting

MR. S. A. E. WELLS said he believed it was generally accepted that gas absorption was a real problem in the case of aluminium, but he asked whether gas troubles were experienced when dealing with magnesium alloys.

MR. ROSS replied that he did not remember hearing of gas trouble in magnesium, but he could say much about gas in aluminium.

MR. WELLS said there was a theory that gas was formed by the core when sulphur was used.

MR. ROSS, whilst he would not claim that trouble had never occurred, said that he could not remember any of the laboratory staff ever being worried about gas in magnesium castings. Many of the moulders who had come from the iron trade had said they had always been told that it did not matter very much whether or not one brought the air off cores when casting in light alloys. This was a mistake. None of this trouble had been experienced in the production of the magnesium castings he had described, but, to revert again to aluminium, a good deal of pin-hole porosity had been encountered which was directly attributable to the air passing through the metal from the cores instead of from vents. In view of this it could be definitely stated that venting was very important.

MR. E. RAYBOULD (High Duty Alloys, Limited) could not concur with the statement often made that magnesium alloys did not absorb gas. It was certainly true, he said, that magnesium alloys were not affected by anything similar to pin-hole porosity in aluminium alloys, but gas evolution had sometimes been noticed when casting water-chilled billets in magnesium alloys. This took the form of violent evolution of gas in the very last stages of solidification, when only the centre or pipe section of the billet remained liquid. This was sometimes sufficiently severe to leave a clean tubular cavity like a worm-hole right up the centre of the billet.

It was rather interesting that Mr. Wells had raised this matter, for in the early days of undercarriage manufacture blow-hole trouble was encountered, and he, Mr. Ross, and their colleagues thought that possibly, because they were using massive risers, an effect was being produced similar to that experienced in billets. This was discounted, as they could never discover any cavities in the risers and usually the blowing could be attributed to insufficient core venting or dirty chills.

This trouble of gas evolution was not normally encountered in sand and die castings on account of the relative rapid solidification as compared with billet casting. It had been encountered particularly in association with the use of certain classes of very dirty or corroded ingot or scrap metal. However much one fluxed this material when melting, gas evolution took place during solidification. In the manufacture of high-class billets for forging, it had been necessary sometimes to forbid the use of such classes of material entirely unless it was first refined and pre-ingoted. There was also a possibility that some processes of magnesium manufacture were more prone than others to give rise to excessive gas absorption. However, it was generally true to say that the occurrence of "gas" did not worry the producers of sand- and die-cast magnesium alloys.

Sand Problems

MR. V. C. FAULKNER asked what was the optimum percentage of moisture that could be carried in a moulding sand used for magnesium castings?

MR. ROSS replied that it was desirable to limit the moisture content to 5 per cent. or less. There had been some nasty accidents due to moulds blowing up when the sand had not been thoroughly mixed. A 5 per cent. moisture content was comfortable.

A SPEAKER asked what percentage of reclaimed sand was used in the moulds.

MR. ROSS said that practically all the sand was reclaimed, apart from the oil-bonded sand which was used for core-making; as much as possible of the floor sand was reclaimed. In reply to a question concerning the content of ammonium bifluoride in the reclaimed sand, he said it did not lose its strength, and it was necessary only to add sufficient to balance the loss. That matter was controlled by the laboratory staff, who made daily checks on the sand.

A SPEAKER asked if special pouring basins were used.

MR. ROSS said that no very elaborate pouring basins were necessary in the production of normal size castings in the light alloys, although, of course, care must be exercised. Obviously special pouring basins were used in the production of the undercarriage casting he had described for it was a special job and a big one; but usually, in the light alloys, one did not produce the very big jobs which necessitated taking very special precautions with pouring basins.

Fluxing

MR. ROSTRON asked what was the minimum percentage of flux necessary for cleansing the metal.

MR. ROSS said that when the furnace was charged, flux was added to the extent of 2 per cent. by weight. When the metal was heated to a temperature suitable for cleaning, the pot was stirred very vigorously and the sides of the pot were scraped in order to clean out the deposits which were there. Then another 2 per cent. of flux was added to the metal, and it was given

(*Continued on page* 146.)

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MAGNESIUM FOUNDRY PRACTICE

(*Concluded from page* 144.)

another stir and cleaned. Finally, a small percentage of flux was added, sufficient to cover completely the surface of the metal, and it remained on the surface until the metal was ready for casting.

MR. ROSTRON said he gathered that the total amount of flux used was about 5 per cent. of the weight of the metal.

MR. ROSS replied that it was probably a trifle less than 5 per cent., but 5 per cent. was a reasonable figure.

MR. FAULKNER said he supposed that cast iron pots were used for melting.

MR. ROSS replied that cast iron and pressed steel pots were used.

MR. FAULKNER asked if the surfaces of the pots were dressed.

MR. ROSS said that they were not; the magnesium did not pick up the iron at all.

MR. ROSTRON asked if the magnesium suffered any ill effects due to "holding."

MR. ROSS did not think so, provided the metal was completely encased, *i.e.*, provided the crust on the top was not broken. With the crust over the top, the temperature needed to refine the metal and to give it the finer grain structure was 850 to 900 deg. He did not think the metal would be harmed so long as it was not exposed to the air; if it were so exposed it would commence to burn.

Heat Treatment

MR. A. J. MURPHY (branch vice-president) congratulated Mr. Ross and High Duty Alloys, Limited, on their courage in accepting the enormous task of producing so important a casting in magnesium alloy. Many people who were working with materials other than magnesium did not realise the difficulties of the tasks which magnesium founders were asked to undertake during the war. Very few of the new magnesium jobs which came into the foundries were ordinary straightforward castings, such as covers, and so forth: they were nearly all class 1 radiologically-examined castings. Thus, the magnesium founders had to proceed with the minimum of delay from the first stage of production to the very highest standard of quality. The casting described by Mr. Ross illustrated that fact very well indeed. He imagined there were very few ferrous castings in the last two or three generations of experience which had had to be made to the standard demanded in the undercarriage casting described in the Paper.

With regard to stress relief, which was brought about by heating for two hours at 300 deg. C., Mr. Murphy asked if there were cases in which the castings had not been subjected to that treatment. In other words, what evidence was there that that treatment was really necessary?

MR. ROSS said he supposed that the stress-relieving heat-treatment was a precautionary measure as much as anything. The casting was very angular, and the stress relief did provide a margin of safety.

MR. MURPHY said he supposed that it had not been worked out very precisely.

MR. ROSS agreed.

MR. MURPHY asked whether much distortion had occurred during the heat-treatment of the castings, for that would constitute evidence of internal stresses.

MR. ROSS said they had not been subjected to full heat-treatment, but only to the modified heat-treatment he had mentioned. However, there was definitely a stress relief, as was evidenced by the fact that if there were no tie-bar across the two legs, those two legs would move together.

MR. MURPHY asked whether the legs moved together when the casting was taken from the mould.

MR. ROSS said they did not at that stage, but they did during the stress-relief treatment.

MR. E. H. BROWN asked what was the section of the tie-bar.

MR. ROSS replied that it was approximately 1-in. maximum.

After MR. J. P. P. JONES and MR. S. A. E. WELLS had expressed the obvious pleasure the members had had in listening to the lecture, the chairman closed the meeting.

INDUSTRY AND EDUCATION

(*Continued from page* 142.)

further factor which has had a great bearing on the reduced influx of young entrants was the unattractive conditions compared with other equally remunerative crafts which offered cleaner and healthier and less fatiguing conditions of employment. This may prove to be one of the foundry's post-war problems if the industry was sincere in its concern to encourage really intelligent boys instead of the type that usually found its way there, often after being rejected as unsuitable elsewhere. He agreed that the school authorities should stress the advantages of an industrial career, and in the national interest heavy engineering should not be neglected. With reference to the training of executives and the suggestion that a youth of 18 to 20 years would possess abilities in the craft of moulding to warrant the term "special moulder" or "under foreman" was a rather optimistic expectation on the part of the authors, and he suggested that an apprentice should prove himself a well-trained practical craftsman over a period of approximately seven years, to be followed by two years' general training in shop management and routine organisation as an alternative.

Otherwise he felt there would be a likelihood of "theoretical" predominating over "practical" knowledge, which, in a craft so prone to natural hazards and pitfalls as foundry work is, deserves very careful consideration. In their general conclusions the authors had given one of the main explanations for the present dearth in foundry apprentices, namely, the terrific overall speed-up in production, this being the logical outcome of mechanisation, but which had brought many evils in its wake, such as monotony to the operators, blind-alley jobs and then death to the apprenticeship system. It could not be too strongly emphasised that parents should be approached and

(*Continued on page* 148.)

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FOUNDRY PLANT & MACHINERY LTD. 113 WEST REGENT STREET GLASGOW

INDUSTRY AND EDUCATION

(*Continued from page* 146.)

acquainted with the prospects, possibilities, and vacancies in industry, and they should be advised that invariably the job that offered the best remuneration at an early stage was usually a blind-alley one, and so detrimental to the boys' interest.

An Outworn System

MR. HARBACH said, in reply, that a study of trade conditions showed that commercial prosperity tended to breed a complacent attitude which adversely affected any progressive movement that prided itself on stability. The foundry industry could not stand still and live, so if due attention was paid to the bad effect of last century's industrial pre-eminence on the foundry, then the trade would again be a progressive one; education of the younger members of the industry and improvement of their working conditions and training would be included in the natural course of progress.

The apprentice system suggested by Mr. Butters seemed too much a copy of the type of schemes at present commonly operated in the foundry. First, he considered seven years too long a training period in view of (*a*) the speed-up in foundry technique, and (*b*) improvement in education which would give greater ability to learn quickly. Secondly, this type of scheme eliminated no one and all starters finish at the same post; therefore it was suggested that at 18 to 20 years of age youths would have shown varying ability and that "good lads" would have the opportunity of more than normal advancement as an encouragement. Mr. Butters' experience as a practical man confirmed observations on (1) the selection of teachers, and (2) the effects of mechanisation and acceleration of productive methods.

BASIC ELECTRIC STEEL PRACTICE

(*Concluded from page* 140.)

or movement in the bath—not an easy thing to get in the quiet bath, absorbing low power.

Phelps judges the condition of the slag by iron-oxide analyses. When this is reported at 0.5 per cent., perhaps 20 to 25 min. after it is completely melted, he adds enough ferro-silicon to bring the metal to required analysis, and (rarely) small amounts of other alloys as necessary to bring within specification. The low iron oxide in the slag (0.5 per cent.) indicates that the metal underneath is well deoxidised, and final silicon can be added without danger of forming silicate inclusions.

H. D. Burke remarked that basic steel castings were generally cleaner than basic electric ingots, which might be caused by one of several factors: Small furnaces have a higher proportionate slag volume, larger slag-metal interface, and a shallower bath—all of which make for more effective slag-metal reactions. Likewise, the foundryman must make a comparatively fluid steel in order to cast his intricate shapes; castability and fluidity usually also make for clean steel.

NEWS IN BRIEF

THE NAME of the British Iron Manufacturers' Research Association has been changed to the British Wrought Iron Research Association.

SURREY SANDBLASTERS, LIMITED, is being wound up voluntarily. Mr. G. C. Jarvis, Ling House, Dominion Street, South Place, London, E.C.2, is the liquidator.

"SURFACE FINISH" will be discussed at an informal meeting of the Institution of Mechanical Engineers to be held on Friday, March 24, at 5.30 p.m. The subject will be introduced by Mr. J. F. Kayser.

TWO STEEL-FRAMED HOUSES, the component parts of which will be capable of mass production and pre-assembly, are to be erected as an experiment at the London County Council's Watling housing estate, Hendon.

A SYMPOSIUM OF SHORT PAPERS on "Some Modern Aids in the Investigation of the Behaviour of Materials, Mechanisms, and Structures" will be presented at a meeting of the Institution of Mechanical Engineers on Friday, March 17, at 5.30 p.m.

THE NEW No. 5 blast furnace of the Algoma Steel Corporation, Limited, Sault Ste. Marie, Ontario, was blown in on November 29. The stack is said to be the largest blast furnace in the British Empire. It has a 25-ft. hearth and is rated at 1,200 net tons (of 2,000 lbs.) per 24 hrs.

THE CHESTERFIELD INDUSTRIAL UNDERTAKINGS' AMBULANCE COMPETITION for the "McGuire" and "Alderman Clark" cups took place on February 6, when the former was won by the Chesterfield Tube Company, Limited, and the latter by the Sheepbridge Coal & Iron Company, Limited.

A BRONZE PLAQUE of Mr. Hans Renold, founder of the Renold & Coventry Chain Company, Limited, Manchester, who died last year, has been subscribed for by the workpeople and was unveiled at the works by Mr. R. Bradshaw, the oldest employee, who has been in the firm's service for 48 years.

THE DIRECTORS of the International Nickel Company of Canada, Limited, have declared a dividend of 40 cents (U.S. currency) on the common shares in respect of the first quarter of 1944. This compares with quarterly common dividends of 50 cents per share which had previously been distributed for several years.

BIRMINGHAM UNIVERSITY seeks to establish a national engineering school, and is asking for £250,000 for new buildings and equipment for the departments of electrical and mechanical engineering. Later, when the new building is up, the University will ask for help to re-equip the civil engineering and mining departments.

THE INDUSTRIAL COUNCIL has rejected claims for increases in the wages of maintenance mechanics at three iron and steel plants and one ironstone mine operated by members of the Lincolnshire Ironmaster's Association in the Scunthorpe district. The claims were for an increase of 20s. a week in the base rates of the men concerned (the bonus to be decreased by the same amount), and for a gross increase of 6s. a week

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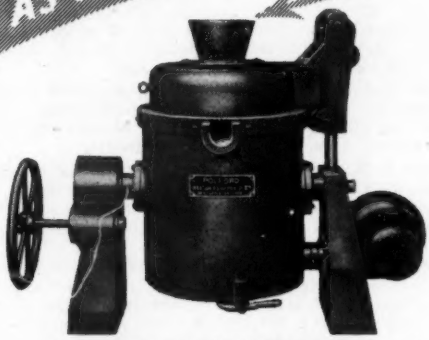

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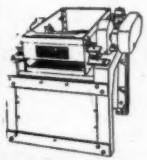

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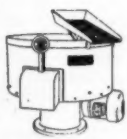

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Makers of Foundry Equipment,

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PERSONAL

LORD BRABAZON has been appointed a director and elected chairman of the Tungum Sales Company, Limited.

MR. ROBERT A. WEAVER, chairman of the Ferro-Enamel Company, has been appointed a director of the American Stove Company.

MR. W. BRADLEY, assistant works manager of Cochranes (Middlesbrough) Foundry, Limited, is leaving to take up a position at another branch of the firm. He joined the company ten years ago.

SIR SUMMERS HUNTER, honorary Regional Director of Merchant Shipbuilding and Repairs, has been nominated for the presidency of the North-East Coast Institution of Shipbuilders and Engineers.

MR. J. W. HALE, who has retired from the board of directors of Bradley & Foster, Limited, Darlaston, has received a presentation from the directors and staff. Mr. Hale has been associated with the company for 21 years.

MR. J. S. WHITMORE has retired from the service of John Lysaght, Limited, and has received a presentation from the men and women in the engineering department of the firm. Mr. Whitmore was appointed chief engineer in 1929. Mr. Whitmore's father and grandfather served the firm before him.

MR. C. W. REEVE, having reached pensionable age, has resigned the appointment of managing director of the Associated Equipment Company, Limited. Mr. Reeve, who remains a director of the company, was re-elected chairman at a recent meeting of the board. No new appointment of managing director is being made.

MR. FRED PARISH has received a presentation in appreciation of fifty years' service with the Hill Top Foundry Company, Limited, Wednesbury. Mr. Parish's father served the company for sixty years. Mr. W. Andrews, who had served the company for fifty-eight years, was to have received a presentation, but was too ill to attend the gathering.

TREATMENT OF WROUGHT LIGHT ALLOYS

The Wrought Light Alloys Development Association has obtained from the United States copies of three instructional films showing current American practice in the machining, riveting and welding of the aluminium alloys. The Association is prepared to lend these films, which have been especially prepared for the guidance of technicians and operatives in the light alloy industry, to interested industrial and educational organisations. The films are entitled, "How to Machine Aluminium," "How to Rivet Aluminium," and "How to Weld Aluminium." In every case where they are shown a member of the Association's staff will be in attendance to answer questions and to supply, if required, further information on the wrought light alloys and their treatment.

COMPANY RESULTS

(Figures for previous year in brackets)

Davies & Metcalfe—Final dividend of 8%, making 11% (same).

Wombwell Foundry & Engineering—Interim dividend of 6% (same).

English Electric Company—Profit for 1943, after taxation, £407,560; dividend of 10% (same).

Colvilles—Dividend on the preference stock in respect of the six months ending March 31 next.

Round Oak Steel Works—Dividend of 6% on the ordinary shares for the year to June 30 last (3%).

Universal Asbestos Manufacturing—Profit, £112,401 (£114,304); E.P.T., £60,000 (£61,500); income-tax, £31,000 (£32,000); ordinary dividend of 20% (same).

British Rola—Trading profit for the year ended March 31 last, £51,784 (£25,377); taxation, £31,308 (£8,562); ordinary dividend of 15% (8¼%); forward, £2,394 (£3,694).

British Steel Constructions (Birmingham)—Profit to August 31 last, £16,140 (£8,734); tax, £7,679 (£3,165); dividend of 15% (7½%); to reserve, £1,867; forward, £5,734 (£5,238).

J. Samuel White & Company—Net profit for the year to September 30 last, £56,240 (£55,733); war damage contribution, £2,244 (£2,823); preference dividend, £4,200 (same); final dividend on the ordinary shares of 4%, tax free, making 6½%, tax free (same); to general reserve, £25,000 (same); deferred repairs, £18,000 (nil); forward, £9,549 (£20,953).

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

W. P. Chesney, Orion Works, Willenhall, Staffs—Brassfounders. £12,000. W. P. and D. E. Chesney.

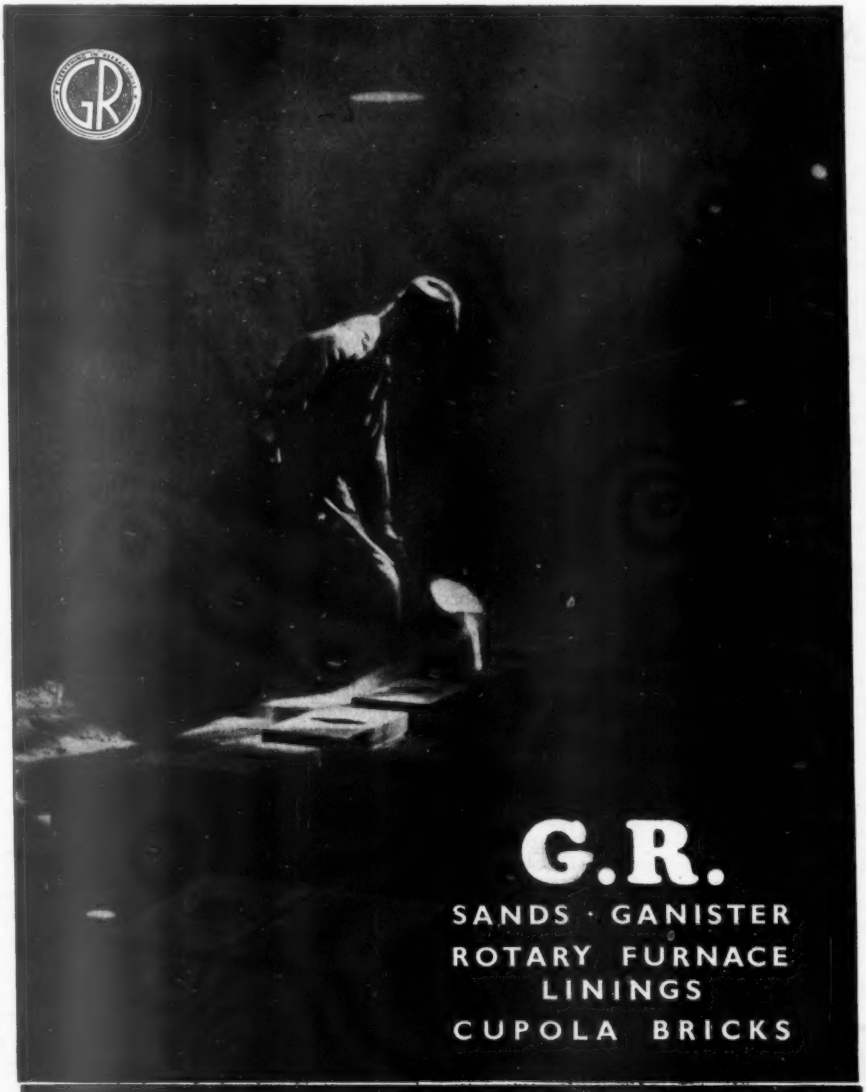
E. W. Engineering Company, 407, Nether Street, Finchley, Middlesex—£7,500. S. H. Ewen and W. A. Westbeech.

Carbidall, Sawrey Street, Feniscliffe, Blackburn—Manufacturers of and dealers in tungsten carbide and other sintered metals and powder metallurgy in all its branches, etc. £3,000. B. H. and M. S. Tattersall.

OBITUARY

MR. GEORGE ROBSON, head of George Robson & Company (Conveyors), Limited, Sheffield, which he founded in 1905, has died at the age of 68.

MR. SYDNEY SOUTHCOTT, of Briton Ferry, died on February 1. He was an active member of the Wales and Monmouthshire branch of the Institute of British Foundrymen and of the Branch Council. He was branch president from 1936/1938, and was awarded the Institute diploma in 1930. Mr. Southcott was foreman at Taylor & Sons, Limited, Briton Ferry, with which firm he had been engaged for the past thirty years. His passing will be regretted by a wide circle of friends in the Institute and throughout South Wales.



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Raw Material Markets

IRON AND STEEL

Difficulties and delays in the clearance of steel supplies from producers' works, which are already exercising a prejudicial effect on production, may be regarded as a foretaste of things to come. It is not unreasonable to suppose that when the great offensives of 1944 are about to be launched the railways will be almost exclusively at the service of the Forces, and only other traffic of the highest priority will be handled. In that event, a further slowing down in the steel trade would be inevitable, and those plants that continued to operate would have to make liberal use of fuel and raw materials already in hand. The announcement of the advances in coke prices following upon the 3s. rise in coal, is not expected to disturb the fixed schedules of iron and steel prices. Nevertheless, it represents a serious addition to the already inflated costs of steel production, which in many instances exceed the maximum permitted price for the finished product. The increase in the case of blast-furnace coke is 4s. per ton. Foundry coke has been advanced by 4s. 6d. Current prices for Durham coke, f.o.t. ovens, are now:—Foundry coke, 58s. 3d.; furnace coke, 48s. 6d.

Uncertainties relating to the availability of rail transport again emphasise the wisdom of accumulating emergency stocks of pig-iron. Latterly the call for high-phosphorus iron has not been sufficient fully to absorb the output, but events may vindicate the wisdom of those who have acquired tonnages in excess of their immediate needs. Possibly prices may remain unaltered, notwithstanding the advance in coke, but the pre-occupation of the railways with military movements may, and probably will, retard the distribution of industrial supplies. Fairly considerable tonnages of low and medium phosphorus iron have been allocated since production was increased, and the hematite position is also a little easier, although the Control still only sanction the use of this grade for approved purposes.

Recent experience has vindicated the prescience of the Control in releasing fairly large tonnages from their reserve stocks of imported steel semis. For the execution of their extensive programme, it is essential that the re-rollers should be assured of ample supplies of re-rolling material. During the past few weeks deliveries have been intermittent, and the mills have at times had to be kept going by inroads into stocks. Fortunately, there are no serious deficiencies in the output of semis, and considerable quantities of defectives, crops, shell-discard steel, etc., are being put to immediate use.

The volume of work in hand at the shipyards seems to be greater than ever. Prefabricators are materially assisting in the further expansion of production, particularly of light craft, the demand for which knows no limit. As a consequence there is an unrelenting demand for thin plates and sheets, and orders in hand will carry the makers well into the second half of the year without any further acceptances. Sections are not quite so heavily specified, but there is nevertheless a brisk demand for the lighter sizes. The requirements of the collieries, as expressed in terms of specifications for bars, arches, props, etc., pursue an upward curve, and the heavy strain on the railways is reflected in a big demand for maintenance material.

NON-FERROUS METALS

Reduction of the output of aluminium indicates that considerable stocks of this metal are now in hand. Supplies are still strictly controlled, but it appears that the requirements of the war effort can be satisfied without any fear of a shortage now or in the future. In the United States the position is even more satisfactory. Production was increased to such an extent that it became well in advance of consumption, and despite the cutting down of output, surpluses are still accumulating.

Consumption of copper has definitely passed its peak, and, in certain directions, still seems to be decreasing. The Rhodesian cut shows that the supply situation is favourable, but it is not yet known whether further curtailments will be made.

The tin market is quiet, and the position is fairly satisfactory, considering the loss of the Far-Eastern supplies; for priority users adequate amounts are forthcoming, and there is no indication of any great shortage. Zinc is in somewhat better supply, as shown by the recent relaxations of the galvanising restrictions, but imports are likely to be kept at a minimum to ease the pressure on shipping.

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